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General

The Pacific Ocean, the largest ocean, is divided by the equator into the North Pacific and South Pacific. The North Pacific Ocean is bordered by North America, Russia, and China.

The South Pacific Ocean is bordered by South America, Antarctica, Australia, and New Zealand.

Oceanic depths are mainly known from lines of soundings run by ships on passage or in connection with the laying of submarine cables and, recently, from oceanographic research.

The Pacific Coast of Central America is typical of much of the known topography of the ocean floor of the North Pacific Ocean. The Middle America Trench, extending from the S end of the Golfo de California almost to Panama, has been explored most thoroughly. It was found, after producing a contour map of the area, that the floor was flat, in part, for several miles across and was V-shaped elsewhere. A thick layer of sediment was found underneath the flat floor, while the V-shaped floor was free of sediment.

Several submarine canyons cut the landward wall of the trench, and a group of basins with varied depths up to about 6,768m and some abyssal hills, presumably submarine volcanoes, are spread out on the floor. Off Baja California, about 1,000 seamounts are located in an area covering 410,000 square miles.

Soundings in the South Pacific Ocean show mainly even depths, but average some 549m or 731m less than in the North Pacific. Between the Hawaiian Islands and Tahiti, and S of the

latter as far as 40°S, the bottom consists mostly of red clay; except around volcanic islands, where volcanic debris and ordinary mud prevails. In nearly all of the soundings, manganese is found.

In other parts of the ocean, where the depth is over 3,658m, the bottom is generally of red clay, but in some cases of soft, gray mud.

The area of the Pacific Ocean, excluding adjacent seas, is about 64,000,000 square miles. The central Pacific trough, extending from the Aleutian Islands to 60°S, and from Japan to the W coast of the United States, has free flow at depths exceeding 3,962m, although numerous elevations and ridges are present.

The W margins of the main Pacific basin are characterized by an almost continuous belt of deep trenches, which generally lie close to the ocean side of long arcs of islands. These regular island chains are separated from the continental shelves of Asia and Australia-New Guinea by marginal seas.

The islands frequently occur in a double belt, the inner belt on the continental side being actively volcanic. Intense seismic activity is also associated with the islands and trenches.

Depths in the great basins appear to be between 3,658m and 5,486m; there are however, some deep trenches near the Marina Islands, Tonga and Kermadec Islands, Japan, and the Philippines, which are from 7,315 to 10,973m deep.

There is also evidence that large numbers of seamounts exist throughout the Pacific, rising in many cases over 3,658m from the ocean floor.

Cautions

The Strait of Magellan separates Archipelago de Tierra del Fuego from the Patagonian mainland and Archipelago Reina Adelaide. The strait was named by its discoverer, Ferdinand Magellan, in 1520. The strait is entered at the W end between Cabo Victoria (52°17'S., 74°54'W.) and Cabo Pilar, about 28 miles SSE.

The E entrance lies between Punta Dungeness (52°24'S., 68°25'W.) and Cabo Espiritu Santo, about 16 miles SW. The distance between the W and E entrances to the strait, through the various channels, is 310 miles.

Vessels must exercise caution when navigating the strait in either direction. In bad weather, which is likely to be the case for more or less protracted periods, the navigation of Magellan Strait is particularly difficult and dangerous. Generally, the anchorages are foul and rocky throughout the strait.

The Coral Sea is bounded on the S by the parallel of 30°S; on the W by the E coast of Australia; on the N by the S coast of New Guinea and the E end of the Solomon Islands; and on the E by the islands of Vanuatu and the SE extremity of New Caledonia.

The three largest reefs in the world, the Great Barrier Reef, off Queensland, the Tagula Reef of Louisiade Archipelago, and the New Caledonia Reefs, lie in the area.

Tsunamis

Tsunamis, named from the Japanese term meaning "harbor wave" are also known as seismic sea waves and are often erroneously referred to as "tidal waves" because they are caused by submarine earthquakes. In the oceans, these waves cannot be detected as they are often over 100 miles in length and only a few meters in height, traveling at tremendous speed, reaching 300 to 500 knots.

On entering shallow water the waves become shorter and higher and on coasts where there is a long fetch of shallow water with oceanic depths immediately to seaward, and in V-shaped harbor mouths, the waves can reach disastrous proportions. Waves having a height of 20m from crest to trough have been reported.

The first wave is seldom the highest and there is normally a succession of waves reaching a peak and then gradually disappearing. The time between crests is usually from 10 to 40 minutes. Sometimes the first noticeable part of the wave is the trough, causing an abnormal lowering of the water level.

Mariners should regard such a sign as a warning that a tsunami may arrive within minutes and should take all possible precautions, proceeding to sea if at all feasible.

Tsunamis travel for enormous distances, up to one-third of the circumference of the earth in the open waters of the Pacific. In 1960, a seismic disturbance of exceptional severity off the coast of Chile generated a tsunami which caused much damage and loss of life as far afield as Japan.

A ship in a harbor, either becoming aware of a large earthquake in the vicinity, or observing sudden marked variations in sea level, or receiving warnings of an approaching tsunami, should seek safety at sea, in deep water.

Although large tsunamis cause great havoc, small waves in shallow water can cause considerable damage by bumping a ship violently on a hard bottom.

The United States and New Zealand Governments maintain tsunami warning systems in the Pacific. In the event of the possibility of a tsunami approaching New Zealand the Civil Defense Organization will at once advise harbormasters, who will in turn inform all merchant vessels in their harbors as quickly as possible.

The signal to be given to warn vessels in harbor to take action is a series of five prolonged blasts. In most ports this signal will be made by sirens (on instructions from the Civil

Defense Organization) which will be situated in positions from which the signal may be heard at all points in the harbor, but in some ports vessels will be advised verbally by the harbormaster.

On hearing this signal, masters are to set radio watches; these watches are to be maintained until the emergency is declared over.

Following this signal harbormasters will take full control of all shipping operations in their area and masters are asked to give their unreserved cooperation.

In certain cases it may be necessary for the harbormasters to order vessels to sea to avoid serious damage being caused to ships and harbor structures by heavy tidal fluctuations in their harbors.

Masters are to advise harbormasters whenever it is intended to carry out engine maintenance which will immobilize their vessels. It should be appreciated by masters that the time available for action after receiving the alert signal may be as long as 18 hours or as brief as 2 hours, depending on the epicenter from where the sea wave is spreading.

In the case of vessels at sea, when a warning of an approaching tsunami is received by the Ministry of Civil Defense advice will be given by the existing navigation warning system.

These warnings may include instructions for ships' immediate movements.

Should a disaster occur ashore, all ships in port and at sea in New Zealand waters may be called upon to provide some of the following assistance at the request of the civil defense authorities:

1. Providing temporary shelter and food for homeless civilians.
2. Providing rations, water, fuel, and power to local authorities.
3. Evacuating civilians to another port.
4. Providing wireless communications.
5. Providing fire fighting parties to assist ashore.

Harbormasters will arrange with masters what assistance each ship in port is able to provide. Ships at sea will be contacted by a normal radio communication system.

Numerous offshore oil rigs, drilling platforms, and seismic survey vessels may be encountered.

Climatology

The Western Pacific is monsoonal. A rainy season occurs during the summer months, when moisture-laden winds blow from the ocean over the land, and a dry season during the winter months, when dry winds blows from the Asian land mass back to the ocean.

Government

Dependent Island Groups

Baker Island

Baker Island is located in the North Pacific Ocean at a position of about 0°12'N, 176°29'W. It is uninhabited and covers an area of less than 1 square mile.

The island was claimed by the United States in 1857. An abandoned airfield is situated on the S end of the island.

The climate is very hot and extremely dry. The vegetation consists of scattered herbs, grass, and low shrubs.

The terrain is low. The nearly level coral island is surrounded by a narrow fringing reef.

Guam

Guam, an unincorporated territory of the United States, is the largest island of the Marianas Archipelago. It is located in the North Pacific Ocean. The island is of great strategic value with large naval and air bases. It is about 30 miles long.

The climate is tropical marine, being generally warm and humid and moderated by NW trade winds. The dry season runs from January to June and the rainy season is from July to December. There is little seasonal temperature variation.

The terrain is of volcanic origin and is surrounded by coral reefs. There are relatively flat coralline limestone plateaus with steep coastal cliffs and narrow coastal plains in the N, low-lying hills in the center, and mountains in the S.

The highest point is Mount Lamlam, 407m high, in the SW.

The administration of Guam is by the Department of Interior.

Howland Island

Howland Island is located in the North Pacific Ocean, in a position about 0°48'N, 176°38'W, almost on the equator, about 1,650 miles SW of Honolulu. It is uninhabited and covers an area of about 1 square mile. It is under the jurisdiction of the United States Fish and Wildlife Service and is declared to be a National Wildlife Refuge.

The climate is equatorial with little rainfall, a constant wind and a burning sun.

The terrain is low-lying, nearly level, sandy, coral-like, and surrounded by a fringing reef with a depressed central area.

Jarvis Island

Jarvis Island, a United States possession, is a small, bleak, coral island, about 2 square miles in extent, located in the Pacific Ocean at about 0°23'S, 160°01'W. It is about 6m high, with large guano deposits in the interior.

In 1936, Jarvis Island was placed, for administrative purposes, under the jurisdiction of the United States Fish and Wildlife Service. The island is uninhabited and is a United States National Wildlife Refuge.

Landing is prohibited except by permit issued by the United States Fish and Wildlife Service, Kailua, Hawaii.

The climate is tropical with little rainfall, constant winds, and a burning sun.

The terrain is sandy and coral-like surrounded by a narrow fringing reef.

Johnston Atoll

Johnston Atoll, an American possession, is located in the North Pacific Ocean at a position of about 16°45'N, 169°31'W, almost on the equator about 1,650 miles SW of Honolulu.

The climate is tropical but generally dry with consistent NE trade winds and little seasonal temperature changes.

The terrain is mostly flat with maximum elevation of 4m.

Johnston Atoll is administered by the United States Defense Nuclear Agency (DNA).

It is managed cooperatively by DNA and the Fish and Wildlife Service of the Department the Interior as part of the National Wildlife Refuge System.

Regulations.—When within 150 miles of Johnston Atoll, the Master should contact the harbormaster by radio telephone on 2716 kHz, calling "Johnston Control." Contact can also be made by ordinary radio if prior advice has been received by the Atoll Commander.

Mariners are cautioned that the waters within 3 miles of Johnston Atoll constitute a prohibited area.

No vessel may enter these waters unless authorized by the United States Naval Authorities and confirmed at least 5 days prior to arrival through the Commander Joint Task Group, Johnston Atoll.

Kingman Reef

Kingman Reef, a United States possession, is located in the North Pacific Ocean about 33 miles NW of Palmyra Island. It is under the control of the United States Navy.

The uninhabited, triangular reef is about 9 miles long and 5 miles wide, sheltering a lagoon with considerable depths. It dries at LW on its NE, E, and SE sides. A small islet, 0.9m high, lies on its E side.

The climate is tropical but moderated by prevailing winds.

The terrain is low and nearly level with a maximum elevation of about 1m.

The waters within the 3 mile limit of Kingsman Reef constitute a prohibited area. No vessel or aircraft, except those authorized by the Secretary of the Navy, shall be navigated in or above the area.

Palmyra Atoll

Palmyra Atoll, a United States possession, is one of the N most of the Line Islands, located in the North Pacific Ocean about 1,000 miles S of Honolulu.

The atoll consists of many small islets lying on a barrier reef which encloses three distinct lagoons, known as West, Center, and East Lagoons.

The islands and islets are low, the highest being only about 1.8m high, but they are covered with coconut palms and other trees, some of which reach an elevation of as much as about 30m.

The barrier reef is reported to be about 8 miles long in an E to W direction.

The uninhabited island has an area of 4 square miles.

The airstrip, roads, and causeways built during WWII have become unserviceable and overgrown.

The climate is equatorial. It is hot and very rainy.

The terrain is low with maximum elevations of about 2m.

Wake Island

Wake Island is located in the North Pacific Ocean, in a position of about 19°18'N, 166°33'E.

It consists of three low-lying islets, Wilkes, Peale, and Wake, which form a horseshoe shape on the reef.

It is separated by narrow, shallow channels and encloses a lagoon, 4.5 miles long and 2 miles wide.

The climate is tropical.

The terrain is coral-like, built up on an underwater volcano.

Mined Areas

Danger Areas

The Pacific Ocean has many dangerous reefs, shoals, and banks rising abruptly from great depth.

Areas Dangerous Due to Mines

Minefields were laid in many parts of the world during World War II. Many of these minefields have been swept; others have had routes swept through them. These routes are mostly marked by buoys and have been used safely by shipping for many years.

Due to the lapse of time, navigation through these minefields whether they have been swept or not is now considered no more dangerous from mines than from any other of the usual hazards to navigation, but in the unswept areas a real danger still exists with regard to anchoring, fishing, or any form of submarine or seabed activity. Furthermore, uncharted wrecks and shoals may lie in these areas.

Even in swept waters and routes there is a remote risk that mines may still remain, having failed to respond to orthodox sweeping methods.

Mariners are therefore advised only to anchor in port approaches and established anchorages. In an emergency it is better to anchor in a swept route rather than in unswept waters.

Drifting mines may occasionally be sighted. All drifting mines should be reported immediately to the naval authorities via the coast radio station. The time of sighting and position of the mine is important in the reporting information so that an appropriate warning to other ships can be broadcast. A drifting mine is best left for the naval experts to deal with.

Rifle fire could pierce the casing and sink the mine without causing it to explode. It will then, if it is near the coast, get washed up on a beach or end up in a trawl in a still lethal state.

Mines, torpedoes, depth charges, bombs, and other explosive missiles are sometimes picked up in trawls, often in waters comparatively distant from New Zealand. Explosive weapons are dangerous even if they have been in the water for many years, and the following guidance is given:

1. A suspected explosive weapon should not be landed on deck if it has been observed while the trawl is still outboard. The trawl should be lowered and where possible towed clear of regular fishing grounds before cutting away the net as necessary. The position and depth of water where the mine was cut away should be passed to the naval authorities via the coast radio station.
2. In the event of the weapon not being detected until the contents of the trawl have been discharged on deck, the master of the fishing vessel must decide whether to rid his ship of the weapon by passing it over the side or to make for the nearest port informing the naval authority via the coast radio station without delay. His decision will depend on the circumstances, but he should be guided by the following points:
 - a. Care should be taken to avoid bumping the weapon.
 - b. If retained onboard it should be stowed on deck, away from heat and vibration, firmly chocked, and lashed to prevent movement.
 - c. It should be kept covered up and damped down. (This is important because any explosive which may have

become exposed to the atmosphere is liable to become very sensitive to shock if allowed to dry out.)

d. The weapon should be kept onboard for as short a time as possible.

e. If within b or c hours steaming of the coastline, the safest measure will generally be to run towards the nearest port and lie a safe distance offshore to await the arrival of a bomb disposal unit. Under no circumstances should the vessel bring the mine or weapon into harbor.

Under no circumstances should attempts be made to clean the weapon for identification purposes, open it, or tamper with it in any way.

A ship with an explosive weapon onboard, or in its gear, should warn other ships in the vicinity giving its position and, if applicable, intended position of jettison.

Remoored mines which have drifted in from deeper water trailing a length of cable are likely to become dangerous should the cable foul some obstruction on the bottom. In this case the mine may not appear on the surface at all states of the tide. Such mines should be reported as drifting mines.

Under no circumstances should an attempt be made to recover a mine and bring it to port, and rewards formerly paid to mariners for such recovery have been discontinued.

Navigational Information

Electronic Navigation and Communication

International Maritime Satellite Organization

Around the world satellite communication systems have now become synonymous with the reliable and quality transfer of information. The International Maritime Satellite Organization (INMARSAT) is an international consortium comprising over seventy-five partners who provide maritime safety management and maritime communications services.

The INMARSAT system consists of a number of satellites, which maintain geosynchronous orbits, and provide quality communications coverage between about 77°N and about 77°S, including locations with less than a 5° angle of elevation. INMARSAT-A, the original system, provides telephone, telex, and fax services. However, this system is being replaced by INMARSAT-B, which, by the use of digital technology, is providing the services with improved quality and higher data transmission rates. INMARSAT-C provides a store and forward data messaging capability, but no voice communication.

Global Maritime Distress and Safety System

The Global Maritime Distress and Safety System (GMDSS) provides a great advancement in safety over the previous usage of short range and high seas radio transmissions. This system, consists of satellite as well as advanced terrestrial communications operations.

The GMDSS has been adopted by the International Convention for the Safety of Life at Sea (SOLAS) 1974. It applies to cargo vessels of 300 grt and over, and all vessels carrying more than twelve passengers on international voyages. Unlike previous regulations, the GMDSS requires vessels to carry specified equipment according to the area in which they are operating. Such vessels navigating in polar

regions must carry VHF, MF, and HF equipment and a satellite Emergency Position Indicating Radiobeacon (EPIRB).

It should be noted that after 1999, compliant vessels will no longer be required to maintain a voice listening watch on VHF channel 16 or 2182 kHz and considerable difficulty may be experienced in establishing communications between a GMDSS and a non-GMDSS equipped vessel.

Global Positioning System

The NAVSTAR Global Positioning System (GPS) is a satellite-based system, operated by the United States Air Force, which provides very accurate positioning, time, and velocity information to multiple users. It is an all-weather system with world wide and continuous usage which will replace OMEGA and other such hyperbolic radio navigation systems. The space component of GPS consists of twenty-four satellites, of which a minimum of six are observable from any place on earth. GPS receivers convert data from the satellites to produce three-dimensional positions (latitude, longitude, and altitude). They compute information for fixes in terms of the World Geodetic System reference ellipsoid. A datum shift correction may be required before a position can be plotted.

GPS provides two services for navigation positioning, but accuracy of a fix also depends upon the capability of the user's equipment. Standard Positioning Service (SPS) is the standard level of positioning and timing accuracy.

It is available without restrictions to any user on a continuous worldwide basis and provides horizontal accuracy to approximately 100m. Precise Positioning Service (PPS) is limited to authorized users and provides horizontal accuracy to approximately 30m.

SafetyNET

NAVTEX is an international automated direct printing service for providing coastal navigational information, distress warnings, and meteorological warnings, including ice reports.

It is an element of GMDSS and has replaced the broadcasts of safety information over MF morse frequencies.

The SafetyNET broadcast system provides the same information as NAVTEX to vessels on the high seas and is delivered by the INMARSAT-C system.

For further information concerning the International Maritime Satellite Organization (INMARSAT), the Global Maritime Distress and Safety System (GMDSS), the SafetyNET system, and the Global Positioning System (GPS), see Pub. No. 9, *The American Practical Navigator* (Bowditch, 1995 Edition); Pub. 117, *Radio Navigational Aids*; and *Annual Notice to Mariners* No. 1.

Seas

Adjacent Seas

The seas adjacent to the North Pacific include the Bering Sea, Sea of Okhotsk, Sea of Japan, Philippine Sea, South China Sea, and Tasman Sea.

The seas adjacent to the South Pacific include the Sulu Sea, Celebes Sea, Arafura Sea, Timor Sea, Banda Sea, Java Sea, Coral Sea, Solomon Sea, and Bismarck Sea in SE Asia.

Gulf of Alaska

The broad indentation on the S coast of Alaska, between the Alaskan Peninsula on the W and the Alexander Archipelago on the E, is comprised of a seamount province and a number of guyots.

The Gulf of Alaska is reported to be frequently rough and to usually have some swell. It is a stormy region in February and November and mountainous seas may be expected.

Bering Sea

The coast along the Siberian side of the Bering Sea is steep-to, and the tidal currents are not strong, but navigation is not easy because of severe climatic conditions, frequent fog and overcast skies, strong winds, short navigational seasons, and the inaccuracy of some existing charts. Some of the surveys on this side date back to examinations by Admiral Litke of the Russian Navy in 1826. Reka Anadyr, flowing into Anadyrskiy Zaliv (Gulf of Anadyr), is the only large river on the Siberian side of the Bering Sea.

The hydrography of the E side of the Bering Sea is fairly well known, but that of the Asiatic side is imperfectly known demanding special caution on the part of the navigator.

The NE part of the sea has one of the largest continental shelves in the world but along the Aleutian chain and the Siberian shore it is very narrow.

The W, S, and SE shores of the Bering Sea abound with volcanoes. Many are active, producing earthquakes and changes in the features of the land. The highest on the W shore is Sopka Klyuchevskaya (56°03'N., 160°35'E.) rising on the E coast of Poluostrov Kamchatskiy.

Komandorskiye Ostrova, lying NW of the Aleutian Islands, forming the S and SE shores of the sea, has no active volcanoes but earthquakes are frequent. These earthquakes are sometimes prolonged and accompanied by a sudden rise in the water level of as much as 3m and over; the level falls again just as suddenly; this fact should be borne in mind when selecting an anchorage.

Sea of Okhotsk

The Sea of Okhotsk, about 1,350 miles in length in a N to S direction and 660 miles in width, is bounded on the SW by Sakhalin, on the W and N by the Asiatic mainland, on the E by Poluostrov Kamchatskiy, and on the S by the Kuril Islands and Hokkaido.

Navigation in the Sea of Okhotsk is difficult during the navigation season because of frequent fog and lack of navigational aids. Vessels should bear in mind that a number of features on the shores may be incorrectly charted, a number of temporary settlements may spring up during the fishing season, and the channels and bars at the river mouths may change.

During the winter all ports are icebound and ice exists in most of the open sea area.

The greatest depths in the Sea of Okhotsk, from 3,000m to a maximum of 3,374m are found in the Kuril Basin along the NW side of the Kuril Islands. From this area the bottom rises rather abruptly toward Sakhalin and the W coast of Poluostrov Kamchatskiy, but more gradually toward the N part of the sea.

In places along the N and NW shores depths of 73 to 92m are found close inshore. The shallowest parts of the sea are along the W coast of Poluostrov Kamchatskiy and at the heads of bays.

The most intense volcanic and seismic activity is concentrated in the Kuril Islands area where about 30 surface and some active submarine volcanoes are found. The strongest earthquakes are concentrated in the Kuril Islands area; weaker quakes are observed on Sakhalin and on the N shore. The NW part of the sea has a minimum of seismic activity.

Sea of Japan

The Sea of Japan lies between the islands of Japan on the E, Korea on the W, and Soviet Union to the N, where Tatar Strait leads to the Sea of Okhotsk. The Sea of Japan is nearly elliptical in outline in a NE to SW direction. Several islands lie within its margins. The maximum depth is 4,049m found at 43°00'N, 137°39'E.

The islands of Japan are mountainous. Three main ranges form an arc; one range extending S from Sakhalin, one running NE from China, through Kyushu and Shikoku, and the third rising parallel with and N of the second. These three ranges join about the middle of Honshu, where they form a range known as the Japanese Alps and include a volcanic chain. The maximum elevation in Japan is attained at the summit of Fuji San (Fuji Yama), which is 3,775m high. It surmounts a weather station.

The S coast of Japan is quite broken, affording a great number of sheltered anchorages; but much of the E and W coasts of Honshu and Hokkaido are slightly indented, with few good harbors. The great natural feature is the Naikai (Inland Sea), bounded by Honshu on the N and by Kyushu and Shikoku on the S, affording a safe sheltered waterway between Kobe and Shimonoseki.

The peninsula of Korea is mountainous, sloping towards the W coast which is indented with several harbors, sheltered by some islands, but somewhat hampered by the large tidal rise and strong tidal currents. The E coast has few harbors.

Yellow Sea

The Yellow Sea lies between Korea and N China. It is one of the marginal seas of the W Pacific lying N of, and adjacent to, the East China Sea. The gulf of Po Hai is at its head.

Large quantities of fine yellow mud are carried down to this sea by the great rivers of North China. They are the Huang Ho (Yellow River), Chang Chiang (Yangtze River), Liao Ho, and the Yalu River.

The N of China is characterized by a yellow earthy deposit of great fertility, called "loess," which fills the valleys to a depth of thousands of feet and covers both low and high ground. It is apt to erode to form terraced precipices. It is soft and easily washed away from the banks of the rivers, so that the rivers change their course frequently and their beds are encumbered by shoals.

East China Sea

The East China Sea lies between the Ryukyu Islands (Nansei Shoto) archipelago and the mainland of China. The mainland coast is low with large offshore mud shoals of silt brought down by the Chang Chiang (Yangtze River) annually in amounts comparable to the discharge of the Mississippi River. The Chang Chiang is over 3,000 miles long. The head of river steamer navigation, at high river level, is Chungking (29°34'N, 106°35'E.) about 1,300 miles above Wu-sung Bar.

The main axis of the Kuroshio (Japan Current) or Black Current, so-named by the Japanese because of the dark blue color of its water, passes through the East China Sea, close W of the Ryukyu Islands.

Like the Gulf Stream, it carries large quantities of warm tropical water to higher latitudes.

South China Sea

The South China Sea extends from Taiwan to Bangka. It provides a direct connection between the North Pacific Ocean and the Indian Ocean.

The sea is about 2,000 miles in length with the Gulf of Thailand as a marginal body of water. Dangerous Ground, a large encumbered area lying W of Palawan, should be avoided by all vessels and is described in Pub. 161, Sailing Directions (Enroute) for the South China Sea and Gulf of Thailand.

In the S part depths do not exceed 183m. The N central part has a maximum depth of 5,030m.

In the deep waters off the Sunda Shelf the seabed is floored with soft mud or ooze, providing a smooth sedimentary surface layer. The depth of the layer is not known, but is probably similar to that of the Pacific Ocean, which is estimated to be about 300m. Patches of sand, coral, and rock surround the reefs and banks in this region.

On the shelf mud is still the dominant sediment, but is interspersed with large patches of sand and smaller patches of rocks, stone, and coral. A belt of sand, about 100 miles wide, extends N from Kepulauan Natuna to the Vietnam coast.

There is a widening belt of sand and mud off the coast of Sarawak and the NW extremity of Borneo. This belt extends NW to the S group of Kepulauan Natuna. There is an extensive mud strip inshore of this belt along the W coast of Sarawak, formed by the discharge of rivers. Mud is extensive off the coast of West Kalimantan, but is replaced in the approaches to Selat Karimata by a predominantly sand bottom.

A mud flooring extends along the NW coast of Borneo and E through Balabac Strait, with offshore patches of rock and coral. The bottom is sand with frequent outcrops of rock and coral along the W coast of Palawan. The bottom is mud in the Palawan Passage.

At the entrance to Manila Bay and along the S shore of that bay, sand, stone, and rock are present but elsewhere, mud from deltaic deposition is found. Mud is also predominant N of Mindoro, but S of that island the bottom is sand, interspersed with patches of coral.

The steep coast W of Luzon and N of Manila Bay is fronted by rocky outcrops, islets, and occasional coral reefs.

The narrow coastal shelf is covered by sand or sand and mud, with mud becoming the predominant sediment between latitudes 16°N and 18°N. The climate of the South China Sea is governed by the NE and SW monsoons and results in a slow and regular climatic variation.

The occurrence of tropical cyclones also varies with the seasons.

The principal islands and island groups of the South China Sea are: on the E, the Philippines and Borneo; in the middle, the Paracel Islands (Xisha Qundao); on the W, Hong Kong and Hai-nan Tao; and on the S, Kepulauan Natuna, Kepulauan Anambas, Singapore, Bangka, and Belitung.

Philippine Sea

The Philippine Sea is a vast area lying S of Japan and N of the Caroline Islands between the Philippines on the W, and the island chain of Palau and the Marianas on the E.

The Mindanao Trench, a narrow trough containing some of the greatest depths in the oceans, lies close to the E coasts of the Philippine archipelago.

Its limits are as yet not fully defined but it appears to be about 600 miles long with a width of from 60 to 100 miles, and extends from off the S end of Mindanao to beyond the N point of Samar. In 1952, H.M.S. Challenger obtained a depth of 10,863m in the trench.

The most striking feature of the E part of the Philippine Sea are chains of seamounts running in a N to S direction. The main island arcs lie in two groups. They are the Solomon Islands and Bismarck Archipelago, lying off New Guinea; and the Marianas.

The Mariana Trench is over 1,000 miles long with an average width of about 40 miles. Near its S end some of the deepest recorded soundings have been obtained.

These include a depth of 11,035m found by the research vessel Vityaz in 1959.

Celebes Sea

The Celebes Sea lies between Borneo and the S part of the Philippines. It is bounded on the N by the Sulu Archipelago and the SW coast of Mindanao; on the E by the chain of volcanic islands connecting the Philippines with Sulawesi; and on the S by the partially volcanic N arm of Sulawesi.

An active submarine volcano rises from a depth of about 4,000m at about 4°N, 124°E.

Otherwise, the basin is characterized by a rather flat bottom with steep sides.

The bottom in the vicinity of active volcanoes is covered with blue or green mud.

Islands and island groups of the Celebes Sea include; on the N, the Sulu Archipelago and Mindanao; on the E, Kepulauan Kawio and Kepulauan Sangihe; on the S, Sulawesi; and on the W, Borneo.

Arafura Sea

The Arafura Sea lies between the SW coast of New Guinea and the N coast of Australia. Weak to moderate earthquakes occur in the vicinity of Kepulauan Kai on the W limit of this sea.

Banda Sea

The Banda Sea lies between Sulawesi and the Tanimbar Islands. The Banda Sea consists of several comparatively flat basins. The volcano, Gunungapi, rises abruptly in the S basin from a depth of about 4,500m to a height of about 280m. The area has a high frequency of earthquakes and volcanic eruptions.

Pulau Unauna erupted on 18 July 1983. Although all the inhabitants were evacuated prior to the eruption, all of the flora and fauna of the island was reported to have perished.

Java Sea

The Java Sea lies between Borneo and Java. In the E, the Java Sea is bounded by the Makassar Strait, the Flores Sea, and

the Bali Sea. The W boundary of the Java Sea is formed by Sumatera, as far as Bangka.

The area is seismically active, with the greatest concentration of volcanic activity in the world. One of the most catastrophic eruptions ever witnessed occurred in Selat Sunda, at Krakatau.

Prior to 1883, Krakatau was an island lying athwart a crater about 4 miles across, technically known as a "caldera." Most of the caldera was underwater, but higher portions of the rim projected above water and successive eruptions had merged volcanic cones across the caldera to form the single island, Krakatau, 8 km by 5 km in extent. Prior to 1883, the only eruption had occurred in 1680. On May 20, 1883, Krakatau again became active. Ash-laden steam clouds reached a height of 6 miles, accompanied by earthquakes and explosions which were felt as far away as Jakarta. Moderate activity continued until the latter part of August.

On August 26, 1883, the character of the eruptions on Krakatau became catastrophic. At 1300, the first of a series of violent explosions occurred, and a black cloud of ash rose 17 miles above the island. The explosions became more and more violent during the night, reaching a climax at 1000 on August 27. The explosions of that eruption were heard as far as Australia, Sri Lanka, and Mauritius. A succession of seismic sea waves swept the shores of Selat Sunda, completely destroying five towns. The tsunami increased greatly in volume and was observed at Pulau Tampurung to rise to 22m; at Pulau Merak, to 36.5m; and from Tanjung Tua to Telukbetung the average height was 24.5m. Every object on the shores of Selat Sunda as far inland as the first range of hills was leveled to the ground, and where the land was low, the sea penetrated as far as 5 miles inland. According to the official report, 36,417 persons perished.

Large quantities of ash fell over an area of 300,000 square miles. Rising high into the upper atmosphere, the fine dust drifted several times around the earth.

When the eruption was over, about 75 percent of Krakatau had disappeared leaving only the islet Pulau Rakata (Pulau Krakatau). Pulau Rakata has an active volcano, Gunung Rakata (6°09'S., 105°26'E.), 813m high.

In 1928, Pulau Anak Krakatau, an islet formed by submarine volcanic activity in the former caldera of Krakatau which is charted as a dangerous area, appeared about 2.5 miles N of Pulau Rakata.

Subsequent eruptions increased the height of Pulau Anak Krakatau to 155m.

Volcanic activity was observed on Pulau Anak Krakatau in 1959, and on Pulau Rakata in 1973. In the event of threatened eruption of Gunung Rakata, the Jakarta radio station will broadcast the necessary warning in Indonesian and English.

In 1977, a massive earthquake on the Indian Ocean floor was reported. A tsunamic wave about 30m high devastated Sumbawa, destroying the village of Ai Kaptapang.

Java Sea depths vary from about 40m or less in the W part, to as much as 60m in the E part. A gently sloping bottom, covered with a layer of unconsolidated sediment (soft mud or in some places mud and sand), has rocky outcrops (predominantly granite) rising abruptly to form groups of islands or shoals.

In some parts, chiefly along the coasts of Borneo, Sumatera, and Java, large rivers flow into the sea causing inshore silting and extension seaward of the coasts. The water is too muddy,

or too fresh, for the growth of coral; but elsewhere the reefs and shores are generally encrusted with coral.

Some extensive coral areas occur near Kepulauan Seribu, NW of Jakarta, and in the vicinity of Bangka and Pulau Belitung. In some shallower parts, chiefly in the vicinity of island groups and on the sills which separate South China Sea from Java Sea, there are large stretches of sandy bottom. These are chiefly areas where the tidal currents are relatively strong. In some places off Tanjung Sambar, the SW extremity of Borneo, and in Selat Bangka, there are elongated sand banks aligned with the direction of the tidal currents, with muddy channels between them.

The largest stony area is in the narrows of Selat Sunda, while the largest area of rocky bottom appears to be the reef extending S from Benkulu, the SW extremity of Sumatera.

However, the central part of the Java Sea has not been closely examined. The area N of Kepulauan Kangean as far as 6°20'S has extensive foul areas due to coral growth and numerous isolated detached patches. It is prudent to adhere to the well-established routes. See the principal descriptions of these localities in the Sailing Directions (Enroute).

Coral Sea

The Coral Sea lies between the SE coast of New Guinea and the Queensland coast of Australia. It includes Torres Strait and extends as far E as the New Hebrides.

The area is characterized by large coral atolls and the world's largest barrier reefs including the Great Barrier Reef of Australia, the Tagula Barrier Reef of the Louisiade Archipelago, and the New Caledonia Barrier Reef.

Bathymetrically, the E margin of the Coral Sea is notable for its great trenches including the San Cristobal Trench, Torres Trench, and New Hebrides Trench.

Solomon Sea

The Solomon Sea, N of the Coral Sea, lies E of New Guinea and S of New Britain and the Solomon Islands. The area is seismically active. There are active volcanoes on some of the islands. Coral reefs abound. Solomon Basin (Planet Deep), in the New Britain Trench, has a depth of 9,140m. Tropical storms tend to be generated in the S part of the area and move S into the Coral Sea.

Bismarck Sea

The Bismarck Sea, part of the SW Pacific Ocean, lies between the N coast of New Guinea and the Bismarck Archipelago.

The area is characterized by numerous seismic disturbances, active volcanoes, and inactive cones. There are numerous sea mounts and submarine volcanoes.